Peer-assisted learning: filling the gaps in basic science education for preclinical medical students

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Submitted 27 January 2015; accepted in final form 4 May 2016

Peer-assisted learning: filling the gaps in basic science education for preclinical medical students. Adv Physiol Educ 40: 297–303, 2016; doi:10.1152/advan.00017.2015.—In contrast to peer-assisted learning (PAL) in clinical training, there is scant literature on the efficacy of PAL during basic medical sciences teaching for preclinical students. A group of senior medical students aimed to design and deliver clinically oriented small-group tutorials after every module in the preclinical curriculum at a United Kingdom medical school. Twenty tutorials were delivered by senior students throughout the year to first- and second-year students. A baseline questionnaire was delivered to inform the development of the program followed by an end-point questionnaire the next year (n = 122). Quizzes were administered before and after five separate tutorials to assess changes in mean student scores. Additionally, each tutorial was evaluated via a questionnaire for participants (n = 949). All five posttutorial quizzes showed a significant improvement in mean student score (P < 0.05). Questionnaires showed students found the program to be relevant and useful for revision purposes and appreciated how tutorials contextualized basic science to clinical medicine. Students appreciated the interactive nature of the sessions and found receiving personalized feedback about their learning and consolidating information with someone familiar with the material to be useful. With the inclusion of the program, students felt there were now an adequate number of tutorials during the year. In conclusion, this study shows that senior medical students can design and deliver a program that adds value to tutorials during the year. In conclusion, this study shows that senior medical students can design and deliver a program that adds value to tutorials during the year. In conclusion, this study shows that senior medical students can design and deliver a program that adds value to tutorials during the year.

How We Teach: Generalizable Education Research

Peer-assisted learning; medical education; preclinical studies; medical student program

Peer-assisted learning (PAL) is an essential feature of medical education. The complexity of the undergraduate course creates many opportunities for senior medical students to educate their junior colleagues. Despite this, PAL in medical education has tended to be largely opportunistic and undocumented, and only recently has it become a requirement for medical students and junior doctors to gain formal teaching experience (26).

PAL benefits both the tutor and the tutee, and many theories have been proposed to explain why PAL might be more effective than traditional teaching methods. Ten Cate and Durning (32) described the concept of “cognitive congruence,” the idea that PAL tutors are able to understand the difficulties faced by the tutees better than established academic staff, having recently gone through the material themselves. Tutees may also feel more relaxed during PAL sessions and consequently ask questions that they were too afraid to ask in the presence of senior academic staff (32). Given the above benefits and evidence that traditional large lecture formats are ineffective in stimulating student learning (20), it is worth considering implementing more PAL programs in formal medical curricula. This would also be in line with the United Kingdom General Medical Council’s recommendation that medical undergraduates should be able to function not only as learners but as mentors and teachers as well (10).

There is presently a large body of literature supporting the efficacy of PAL in the clinical training of medical students. PAL strategies have been effectively used in the teaching of physical examination (2, 5, 23, 31), resuscitation algorithms (22), ultrasonography (6, 18), and surgical skills (28). Indeed, some studies even shown that trained student teachers could provide a quality of clinical training comparable with that of experts (26, 33).

In contrast to clinical training, there is relatively scant literature on the efficacy of PAL in the teaching of basic medical sciences to preclinical medical students. The few initiatives that have been published have been limited in scope and scale, focusing on a single basic medical science topic, often anatomy (7, 8, 12), or being carried out as a one-off revision session (25). Recently, attempts have been made to implement student-led teaching in a manner that more accurately mirrors the breadth and scale of the preclinical medical science curriculum. Two separate authors have described the successful implementation of staff- and student-led medical physiology tutorial programs that complemented the basic medical science curriculum in St. George’s University School of Medicine, West Indies (17), and Brighton and Sussex Medical School, United Kingdom (15). In each of these programs, six structured tutorials were given to a single-year cohort of preclinical students, scheduled in such a way as to coincide with the relevant body system being taught in the core curriculum (15, 17). Posttutorial feedback showed that tutees found the student-led tutorials useful for consolidating core material and that they had a positive impact on their learning of medical science.

We aimed to use PAL to address what we considered “gaps” in the preclinical curriculum, namely, the lack of small-group tutorials and face-to-face interactions and guidance from knowledgeable staff. The MBBS undergraduate program at University College London Medical School (UCLMS) is a 6-yr course, with the first 2 yr focusing on the basic sciences underpinning clinical practice. It has historically had a relatively traditional structure but has recently transitioned toward a more integrated curriculum. A predominantly lecture-based format is used to teach modules (4- to 6-wk teaching blocks) covering foundations in physiology, anatomy, pathology, biochemistry, and pharmacology (35). As part of the formal curriculum, there are only 12 small-group tutorials relating to physiology or pharmacology over the 2 yr.
We implemented a novel peer-assisted case study (PACS) tutorial program specifically designed to complement the core basic science curriculum at UCLMS. The aim of the program was to enhance the learning of difficult or clinically important basic science topics through clinical case studies. The program was ambitious in its breadth and scope, aiming to cover all the major basic medical science topics taught in both the first and second year of the curriculum. A total of 20 structured tutorials were run, covering aspects of basic medical science including physiology, biochemistry, pharmacology, data interpretation, and anatomy. The program was entirely student led from its initial conception to its execution; however, all tutorial content was approved by UCLMS teaching staff to ensure factual accuracy.

Here, we describe the design and execution of the PACS tutorial program and analyze the effectiveness of the program in supplementing medical student learning. In particular, we aimed to answer the following questions:

1. Can senior medical students design and organize a comprehensive, 20-tutorial teaching program for preclinical students?
2. Can this program effectively complement formal medical school teaching?

METHODS

The PACS program: an introduction. The PACS program was a case-based tutorial program comprising 20 tutorials delivered by senior medical students. Preclinical students received two structured, hour-long, evening tutorials for each module. The two tutorials ran on consecutive weeks toward the end of each module, so as to coincide with the formal teaching delivered by the medical school and allow students to consolidate their learning before progressing to the next module. Where possible, students remained in the same group and with the same tutor for both of the tutorials in a given module. In addition, students were encouraged to read through the material covered in relevant lectures beforehand to identify areas of difficulty, allowing them to fully participate in small group work and discussions during tutorials.

Creation of tutorial content. We recruited a group of medical students to be content writers for the program. Each received an information pack detailing their role and containing guidelines for creating the workbooks. In total, 20 workbooks were created for the entire program; each contained a case-based clinical scenario with integrated questions and, additionally, two exam-style single-best answer (SBA) questions. Importantly, workbook content was influenced by questionnaires distributed before starting the program (see below). All workbooks were vetted and approved by the medical school’s module leads before being used for the tutorial sessions. An example workbook is shown in APPENDIX B.

Tutor recruitment. For each module, 6–10 medical students who had completed their preclinical studies were recruited to be tutors. Interested students completed an online application form in which they were asked to detail their previous teaching experience and write a short personal statement explaining why they wanted to be a tutor.

Tutors were given the tutorial workbooks, with answers, and an information pack detailing the aims of the PACS program and outlining what would be expected of them. Tutors also received an instructional video that explained how to conduct the tutorials, emphasizing the importance of giving feedback and interacting with the students. Finally, tutors also received a brief teaching method course, which was run by a senior faculty member.

Data collection. Data collection was based on two consecutive cohorts of students. The first cohort of students in the 2013/2014 academic year were given questionnaires before and after the program as well as after every tutorial. The second cohort of students in the 2014/2015 academic year were given pre- and posttutorial quizzes to assess learning performance. No significant changes were made to tutorial content, style, or delivery between the two cohorts.

In the first cohort of students, we assessed students’ opinions about the program using pre- and postprogram questionnaires as well as similarly structured questionnaires after each tutorial. Before the commencement of the program, a questionnaire (shown in Fig. 1, light shaded bars) was distributed to current first- and second-year students...
Table 1. Cohort averages and SDs per question

<table>
<thead>
<tr>
<th>Question 1: relevance</th>
<th>Question 2: Interactive</th>
<th>Question 3: revision guidance</th>
<th>Question 4: Contextualizing information</th>
<th>Question 5: continue next year</th>
<th>Question 6: tutor presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.84</td>
<td>4.78</td>
<td>4.72</td>
<td>4.53</td>
<td>4.92</td>
</tr>
<tr>
<td>SD</td>
<td>0.38</td>
<td>0.46</td>
<td>0.54</td>
<td>0.65</td>
<td>0.33</td>
</tr>
</tbody>
</table>

To assess learning performance, we asked the second cohort of students to complete short pre- and posttutorial quizzes during 5 of the 20 tutorials scheduled for them. Each quiz comprised five SBA questions that tested concepts directly relevant to tutorial content. Students had 5 min before and after the tutorial to attempt the quiz. They were supervised by the tutors and encouraged not to collaborate. Differences between the means of pre- and posttutorial quiz scores were analyzed using a Wilcoxon signed-rank test. A 5% significance level was used to detect differences in quiz performance.

RESULTS

The average attendance over the course of the year was 123 students (37% of the year group) per year 1 module and 82 students (25% of the year group) per year 2 module. One hundred twenty-two participants completed the end-of-year evaluation form, and, over the year, a total of 949 responses evaluating individual tutorials were collected.

Figure 1 shows student responses from the preprogram questionnaire and postprogram questionnaire. Before the program, 8.3% of students agreed or strongly agreed that there was an adequate number of small-group tutorials as part of the curriculum (Fig. 1A, light shaded bars). Taking PACS into account, this rose to 78% after the end of the program (Fig. 1A, dark shaded bars). Similarly, 53% of students agreed or strongly agreed that they had an excellent understanding of how basic science translates to clinical practice before the rollout of the program (Fig. 1B, light shaded bars). Most of the students (97%) agreed or strongly agreed that the PACS program significantly contributed to this understanding (Fig. 1B, dark shaded bars). Few students (7.8%) strongly agreed or agreed that they had many opportunities to consolidate information with someone who knows the material well (Fig. 1C, light shaded bars); 96% of students agreed or strongly agreed that PACS significantly added such opportunities (Fig. 1C, dark shaded bars). Finally, 87.2% of students who had not experienced the program agreed or strongly agreed that they often didn’t know if they were revising the right things and to the right level of detail. After completion of the program, 89% of students agreed or strongly agreed that PACS helped direct their revision throughout the year (Fig. 1D, dark shaded bars).

Figure 2 shows mean student scores in SBA quizzes administered before and after five separate tutorials. The tutorials covered three modules: Fluids, Nutrition, and Metabolism; Reproduction, Development, and Genetics; and Pharmacology. The mean score for Fluids, Nutrition, and Metabolism 1 rose from 40% to 71% ($P < 0.01$); for Fluids, Nutrition, and Metabolism 2, the mean score rose from 28.9% to 68.9% ($P = 0.01$); for Genetics, the mean score for Reproduction, Development, and Genetics (RDG); and Pharmacology (Pharm). Error bars reflect SEs.
0.01). For the Reproduction, Development, and Genetics tutorials, the mean score for Reproduction, Development, and Genetics 1 rose from 53% to 88.2% ($P < 0.01$) and Reproduction, Development, and Genetics 2 from 55% to 71% ($P < 0.021$). The Pharmacology tutorial pretutorial quiz mean score was 42.8%, which increased to 78% ($P < 0.01$) after the tutorial.

With regard to individual tutorials, respondents showed great support for the program (Table 1). The majority of students strongly agreed that the tutors presented the information well and that the tutorials were relevant to the formal curriculum, interactive, and clinically orientated. Respondents also overwhelmingly supported the program running in subsequent years, with only 8 of 949 responses (0.8%) disagreeing, strongly disagreeing, or feeling neutral to the program running the next year.

**DISCUSSION**

This is currently one of the few studies that has explored the efficacy of PAL for basic science teaching to preclinical students (13, 15, 17, 34). Our subjective data show that the tutorials were well received by students. The primary aim of the present study was for senior medical students to help fill gaps in the curriculum. Tutee feedback consistently showed that the tutorials were successful in highlighting the relevance and context of various taught elements, which were barely present, in the taught modules at the time. The program fared well with objective measurements, showing that tutees had significant improvements on topic knowledge. The fact that this program covers every preclinical module of the formal curriculum separates this from the other studies (15, 17, 34). A similar student-devised project took place in the United States (13) but lacked clinical contextualization, had paid tutors, and was delivered to a substantially smaller cohort.

This approach can be framed in the context of certain educational principles. Preclinical medicine is vast. To meet the need of covering the appropriate breadth and depth, a didactic lecture-heavy timetable has been adopted at UCLMS with key concepts compartmentalized and taught in isolation. This results in substantial cognitive demands to integrate knowledge and form new schema (37). The tutorials helped by chunking material, providing context and applicability to aid comprehension and integration of content. This helps reduce the cognitive load (37). Contextualization is important in andragogy as “meaningfulness” plays a key role in learning (16) and application aids how information is mentally organized (1). The tutorials added meaningfulness and aided the development of schema.

Another strength of this program was its sole conception and delivery by near peer students. With near-peers controlling tutorial content, topics included were those found to be most difficult from the preclinical course. This approach has been successful in other educational programs (13, 24). The cognitive congruence provided by near-peers means that students are able to identify needs missed by faculty members (9), create student-centered resources (9), and have tutors who can accurately relate to students’ anxieties and knowledge levels (3, 11). The proximity, relatability, and approachability of near-peer tutors are advantages (19), and this was reflected in extremely positive subjective feedback (Table 1).

The programme also benefitted the medical school. Students agreed that with these tutorials present, there were now an adequate number of small-group tutorials available to them. This shows the program’s ability to provide interactive learning sessions with intergroup consistency, which students felt the formal curriculum lacked. Furthermore, UCLMS is transitioning to a more integrated curriculum, aligning with the General Medical Council’s recommendation that courses “integrate the learning of basic and clinical sciences” so that students “link theory and practice” (10). PACS synergizes with this by framing content clinically. Many in the faculty praised the program for achieving such integration. This program has extended the scope of preexisting PAL initiatives at UCLMS (9) to basic sciences.

The benefits to tutors delivering near-peer teaching are well established. These range from skill and knowledge development to identity formation (3, 4). Many tutors reapplied to teach more sessions, citing enjoyment, fulfilment, and a sense of duty as their motivations. Moreover, we contend that an independent student-led program was instrumental in exposing the organizers to facets of education extending beyond teaching. This was especially true regarding perspectives in educational theory and practical considerations when running a large-scale project (12, 36). Team members also had their interest in educational research spurred and hope to be involved in education after graduating, as observed elsewhere (21).

Given the student-led nature of the program, there were concerns regarding content and tutor quality. Academic staff approved the tutorials before the scheme starting to resolve any content issues. Tutors were regulated at several points, starting with a competitive application process. Second, tutors received various modes of support and incentives to guide their preparations (29). Finally, tutors were evaluated as the scheme progressed, with committee members observing sessions and reviewing tutees’ feedback to ensure that improvements could be made before the next session. This was sufficient to yield extremely positive feedback from tutors and tutees alike (29). Of note, the results shown in Fig. 1 indicate the acceptability of clinical students as near-peer tutors for basic science as “somebody who knows the material well.” This is in line with analogous studies in other domains showing the acceptability of PAL (2, 6, 18, 22, 23, 31).

We were concerned with recruiting enough tutors given their voluntary participation. However, tutor applications were always oversubscribed, with an average of 4 applicants/place. We had enough tutors should an entire cohort sign up and also have two standby tutors per night. This probably rests with there being a pool of $>1,000$ clinical students who are eligible to be tutors. Many applicants had intercalated degrees relating to the module they wished to teach. This highlights their enthusiasm for the subject and an aptitude greater than that which the preclinical course requires. While this does not absolutely negate concerns of aptitude, it supports the notion that near-peer tutors may be a self-selecting, high-achieving group (14).

Conversely, tutee attendance was below what we predicted. On average, approximately one-third of each year attended any one tutorial. Compared with another program of similar nature and cohort size, the proportion of students attending plateaued at 20% (17). This, coupled with the lack of data on an individual
tutees’ attendance, makes it difficult to make solid inferences for the effect of the program on the year group as a whole. Like Hurley et al.’s program (13), not all who signed up attended. Lack of attendance could be due to clashes with other activities, increasing confidence with the material negating the need for further support, or fatigue after a long day of lectures.

In terms of improving the program, monitoring individual attendance would allow us explore longer-term impacts. Whether these tutorials could be included in the formal curriculum should also be explored. From tutees’ comments, more time and SBAs were requested. We are mindful of increasing tutorial length given that they are held in the evening, after days full of lectures. Given that this program’s primary purpose is to consolidate content, we are cautious of adding more SBAs as it poses a risk of making it too exam focused, which goes against the integrative ethos of the program.

This study’s most significant limitation relates to the unknown long-term impact of the tutorials. Whether attending the tutorials makes an educationally significant difference in summative assessment performance needs investigation. Some studies have shown an association between supplementary PAL sessions and improved exam results (15, 27, 34, 30). A similarly styled scheme showed attendees mostly attained higher marks against a historical cohort (15). However, these were immediate end-of-module exams and contrasts with UCLMS’ end-of-year exam format. Additionally, pre- and posttutorial quizzes were administered in only 5 of 20 tutorials for logistical reasons. The quizzes should be ideally have been administered at all tutorials. With regards to comparisons between different cohorts, both the program and formal curriculum had no substantial changes, and, therefore, we are confident that appropriate comparisons can be made between them.

In conclusion, senior medical students can positively contribute to the medical school teaching of basic science by creating and delivering tutorials that complement the curriculum. This study reinforces the acceptability, positive reception, and academic contribution of near-peer tutors when teaching basic science. Further work should aim to explore long-term academic benefits of this program in the context of a lecture-based basic science curriculum. The program shows that, with adequate planning, students can devise, administer, and deliver basic science tutorials that run throughout the academic year.

APPENDIX A

Table 2 shows the tutorial content.

APPENDIX B

Table 3 shows an example workbook section.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS


REFERENCES


Table 2. Tutorial content

<table>
<thead>
<tr>
<th>Year Group</th>
<th>Tutorial content</th>
<th>Foundation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tutorial 1: embryology</td>
<td>Foundations of Health and Medical Practice</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: hematology</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tutorial 1: severe combined immunodeficiency to explain immunodeficiency</td>
<td>Infection and Defence</td>
</tr>
<tr>
<td></td>
<td>and infectious diseases</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: systemic lupus erythematosus to explain immunological tolerance and hypersensitivity</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Tutorial 1: COPD to explain respiratory physiology</td>
<td>Circulation and Breathing</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: heart failure to explain cardiovascular physiology</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Tutorial 1: celiac disease and diabetes mellitus to explain gastrointestinal physiology and biochemistry</td>
<td>Fluids, Nutrition, and Metabolism</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: renal anatomy and physiology and pharmacology of diuretics</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Acid-base balance disorders, arterial blood gases, the cardiac cycle, ECG, and lung volumes</td>
<td>Data Interpretation</td>
</tr>
<tr>
<td>2</td>
<td>Tutorial 1: upper limb anatomy and pathology</td>
<td>Movement and Musculoskeletal Biology</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: lower limb anatomy and muscle physiology</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tutorial 1: stroke to explain neuroanatomy</td>
<td>Neuroscience and Behavior</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: Parkinson’s disease, Alzheimer’s disease, and depression</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tutorial 1: diabetes mellitus and thyroid disease</td>
<td>Endocrine and Systems Regulation</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: physiology and pathophysiology of adrenal gland defects</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tutorial 1: genetics</td>
<td>Reproduction, Development, and Genetics</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: reproductive physiology and treatment of fertility</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tutorial 1: cardiovascular drugs and antibacterials</td>
<td>Pharmacology</td>
</tr>
<tr>
<td></td>
<td>Tutorial 2: neuropharmacology and Pharmacokinetics</td>
<td></td>
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</tbody>
</table>

COPD, chronic obstructive pulmonary disease.

Advances in Physiology Education • doi:10.1152/advan.00017.2015 • http://advan.physiology.org
### Table 3. Example workbook

<table>
<thead>
<tr>
<th>Case Scenario and Questions</th>
<th>Intended Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case: Mr. K is a 48-yr-old man who has COPD due to chronic bronchitis and asthma.</strong> He used to work in a dusty warehouse operating forklifts to move crates around. He is a heavy smoker, having smoked 40 cigarettes/day for the first 12 yr but has cut down to 13 cigarettes/day for the past 17 years. He is constantly coughing, regularly expectorating green phlegm several times a day, and gets breathless very easily. You are the respiratory physician in charge of his care, and he has come to your clinic for a routine checkup. What is COPD?</td>
<td><strong>• Explain that COPD is an umbrella term that encompasses the chronic and irreversible aspects of several major obstructive lung diseases, mainly emphysema and chronic bronchitis, but also the irreversible aspects of asthma.</strong> <strong>• Students gain a general appreciation of some of the risk factors</strong> <strong>• Ensure that students are familiar with calculating pack years and understand it aids as an indicator of risk for various lung pathologies.</strong> <strong>• Ensure that students are familiar with the definitions of these terms and the normal values.</strong> <strong>• Explain that the significance of the FEV1-to-FVC ratio is to help distinguish between restrictive and obstructive disorders.</strong> <strong>• Ensure that students understand that the FEV1-to-FVC ratio is decreased in an obstructive disorder. Also, FEV1 is decreased, but FVC is normal or slightly reduced.</strong> <strong>• Explain that this occurs because those with obstructive conditions have greater airway resistance, which predominantly impedes the expiratory process. This is particularly the case during forced expiration, as the positive intrapleural pressure tends to cause the airways to collapse, trapping air within the lungs.</strong> <strong>• Students gain a general appreciation of asthma: its symptoms, triggers, and pathophysiology.</strong></td>
</tr>
<tr>
<td><strong>What are the risk factors for COPD?</strong> Being a heavy smoker, Mr. K was clearly at risk for COPD. How many pack years has Mr. K had?</td>
<td><strong>• Ensure that students understand that tobacco smoking is the most important risk factor for COPD.</strong> <strong>• Explain that the risk of COPD increases with cigarette pack years. The number of cigarettes smoked per day is multiplied by the number of years of smoking to get the number of pack years.</strong></td>
</tr>
<tr>
<td>During the checkup, you perform some lung function tests on Mr. K. You calculate his FVC, FEV1, and FEV1-to-FVC ratio. How would you define these terms? What is a normal FEV1-to-FVC ratio? What is the diagnostic significance of this ratio in a patient with a respiratory condition?</td>
<td><strong>• Define FVC as the maximum volume of air that can be exhaled after a deep inspiration. FEV1 is the volume of air expelled in the first second of forced expiration. The FEV1-to-FVC ratio is a measure of airflow limitation.</strong> <strong>• Describe a normal FEV1-to-FVC ratio as being 0.7 or greater.</strong> <strong>• Explain that an FEV1-to-FVC ratio less than 0.7 indicates obstruction.</strong></td>
</tr>
<tr>
<td>Draw a graph illustrating normal pulmonary function tests. On the same diagram, draw another graph indicating how Mr. K’s lung function tests would look like compared with a normal person. Why the difference?</td>
<td><strong>• Explain that COPD is characterized by reduced FVC and FEV1 values, and a decreased FEV1-to-FVC ratio.</strong> <strong>• Demonstrate that Mr. K’s lung function tests would show a reduced FVC, FEV1, and FEV1-to-FVC ratio compared to a normal person.</strong></td>
</tr>
<tr>
<td>Mr. K has an asthmatic component to his COPD. What are the typical symptoms of asthma? What are some factors that can trigger an asthma attack? What type of hypersensitivity reaction underlies asthma? What type of immunoglobulin is associated with this?</td>
<td><strong>• Define asthma as a chronic inflammatory disease of the airways triggered by multiple factors.</strong> <strong>• Explain that asthma is characterized by the presence of inflammatory cells, in particular eosinophils, and the release of inflammatory mediators.</strong> <strong>• Discuss the role of IgE antibodies in the pathophysiology of asthma.</strong></td>
</tr>
<tr>
<td>A year later, Mr. K returns to your clinic. He shows signs of labored breathing, and you find this his lips and nail beds are blue. Mr. K’s arterial blood gases are measured. He was found to have a PaO2 of 48 mmHg and PaCO2 of 69 mmHg. In broad terms, how are arterial blood gases detected by the body and how are they involved in the control of ventilation? How are the chemoreceptors classified and what do they detect?</td>
<td><strong>• Explain that arterial blood gases are measured by sampling arterial blood from a peripheral artery.</strong> <strong>• Discuss the role of chemoreceptors in detecting changes in PaO2, PaCO2, and pH levels in the blood.</strong> <strong>• Describe the classification of chemoreceptors: central and peripheral.</strong> <strong>• Explain that central chemoreceptors are involved in detecting changes in PaCO2 and pH levels in the blood.</strong> <strong>• Describe the function of peripheral chemoreceptors in detecting changes in PaO2 levels.</strong></td>
</tr>
<tr>
<td>In a normal person, which is more important in the control of ventilation: PaO2 or PaCO2? Is this the case for Mr. K?</td>
<td><strong>• Ensure that students understand that in a normal person, hypercapnic drive is more important than hypoxic drive in the control of ventilation.</strong> <strong>• Explain that in Mr. K’s case, it is likely that the hypoxic drive is more important than the hypercapnic drive in ventilation.</strong> <strong>• Discuss the fact that he is severely hypoxic, in patients with chronic hypercapnia due to longstanding COPD and respiratory failure, the central chemoreceptors become tolerant of the high CO2 levels and also become less sensitive to changes in CO2 levels.</strong> <strong>• Explain that this occurs because those with obstructive conditions have greater airway resistance, which predominantly impedes the expiratory process. This is particularly the case during forced expiration, as the positive intrapleural pressure tends to cause the airways to collapse, trapping air within the lungs.</strong> <strong>• Students gain a general appreciation of asthma: its symptoms, triggers, and pathophysiology.</strong></td>
</tr>
</tbody>
</table>

Two single-best answer questions

FVC, forced vital capacity; FEV1, forced expiratory volume in 1 s; PaO2, arterial PO2; PaCO2, arterial PCO2.


